

*DARDANUS IMBRICATUS* (H. MILNE EDWARDS) AND DESCRIPTIONS OF THREE NEW SPECIES OF *DARDANUS* (DECAPODA, ANOMURA, DIOGENIDAE)

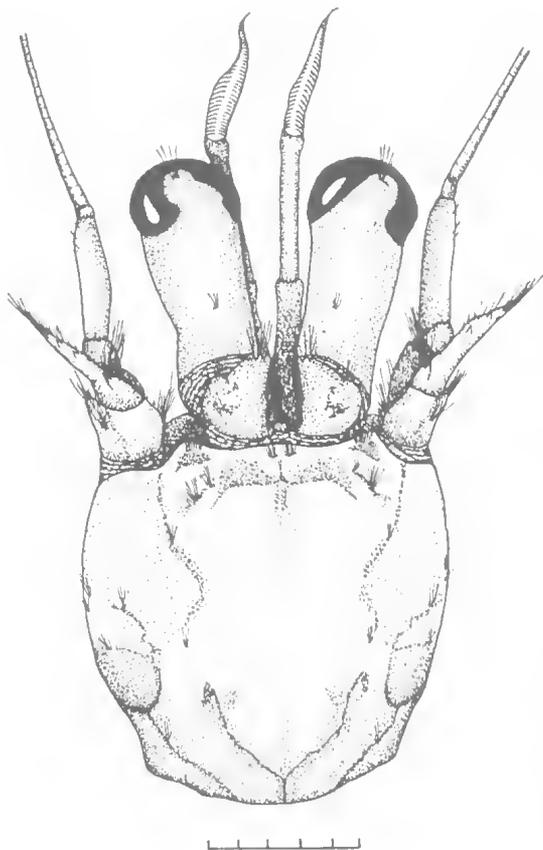
S.D. COOK

Cook, S.D. 1989 11 13: *Dardanus imbricatus* (H. Milne Edwards) and descriptions of three new species of *Dardanus* (Decapoda, Anomura, Diogenidae). *Mem. Qd Mus.* 27(2): 111-122. Brisbane. ISSN 0079-8835.

Three new hermit crab species of *Dardanus* — *D. callichela*, *D. corrugatus* and *D. squarrosus* — are described. All fit the original description of *Dardanus imbricatus* (H. Milne Edwards, 1848). As the holotype of *D. imbricatus* is presumed lost a neotype is erected and a redescription given. All species are compared to the little known *D. undulatus* (Balss, 1921). Species are separated on eye-stalk length and characteristic sculpturing on the outer surfaces of the left cheliped and third left leg.

□ Crustacea, Anomura, Diogenidae, *Dardanus*, new species.

S.D. Cook, Queensland Museum, PO Box 300, South Brisbane, Queensland 4101, Australia; 29 November, 1988.



The collections of the Queensland Museum contain two species of *Dardanus* which fit H. Milne Edwards' (1848) description of *Pagurus imbricatus*. In an attempt to clarify the situation, examination of as much material as possible was undertaken. This revealed another two species closely related to each other, agreeing with Milne Edwards' description but differing from the preceding two species by having long eye-stalks. The description and figure of *Dardanus undulatus* (Balss, 1921) show features similar to some of the present material so examination of the type specimen was undertaken. Characters unique to the group of species included here, and features that can be used to separate the species from each other are given in the general discussion at the end of the paper.

Measurements given are of shield length measured in mid-line. Line drawings were done with the aid of a *camera lucida*. Abbreviations used are: AM Australian Museum, Sydney, Australia. BM British Museum (Natural History), London, United Kingdom. MNHN Museum National d'Histoire Naturelle, Paris, France. NRS Naturhistoriska Riksmuseet, Stockholm, Sweden. NTM Northern Territory Museum of Arts and Sciences, Darwin, Australia. QM Queensland Museum, Brisbane, Australia. WAM Western Australian Museum, Perth, Australia.

***Dardanus imbricatus*** (H. Milne Edwards, 1848)  
(Figs 1,2,6A)

FIG. 1. *Dardanus imbricatus* (H. Milne-Edwards). Shield and cephalic appendages. Neotype, ♀ (11.6mm), NTM Cr.3444. (Scale = 5.0mm).

*Pagurus imbricatus* H. Milne Edwards, 1848, p.61; Miers, 1876, p.66; 1884, p.185,264; Hutton, 1882, p.264; Filho, 1886, p.424.

?*Pagurus imbricatus*: Henderson, 1888, p.57; Ortman, 1894, p.30.

*Dardanus imbricatus*: McNeill, 1968, p.31; Haig and Ball, 1988, p.165.

Not *Dardanus imbricatus* Rathbun, 1910, p.556, pl.49, fig.3. (= *Pagurus peruensis* Balss, 1921, p.21).

#### MATERIAL EXAMINED

NEOTYPE: NTM Cr.3444 ♂ (11.6mm), Casuarina Beach, Darwin, 12°20.85'S, 130°52.80'E, storm debris, 22/1/1986, C.Hood.

OTHER MATERIAL: AM P18937 ♂ (11.7mm), off Carnarvon W. Aust., 24m, May 1972, A.Nickol; QM W10515 ♂ (6.6mm), NW Shelf, 19°56.9'S, 117°53.5'E, 42-43m, 18/2/1983, T.Ward R.V.*Soela* CSIRO; QM W10516 ♂ (11.9mm), NW Shelf, 19°28.4'S, 118°55.1'E, 37-38m, 25/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10517 ♀ (9.6mm) NW Shelf, 19°45.8'S, 117°52.1'E, 52m, 2/9/1983, T.Ward R.V.*Soela* CSIRO; QM W10519 ♀ (3.4mm), NW Shelf, 19°56.8'S, 117°53.3'E, 44m, 25/6/1983, T.Ward R.V.*Soela* CSIRO; QM W10524 ♂ (7.0mm), ♀ (4.3mm), NW Shelf, 19°29.6'S, 118°52.2'E, 40m, 25/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10525 2♂ (5.4-9.3mm), ♀ (4.5mm), NW Shelf, stn 48, 20°25.4'S, 116°02.6'E, 38m, 14/10/1983, I.Poiner CSIRO; QM W10526 ♂ (7.0mm), NW Shelf, 19°58.9'S, 117°51.3'E, 40m, 22/4/1983, T.Ward R.V.*Soela* CSIRO; QM W10528 3♂ (3.0-8.1mm), 2♀ (3.0-3.5mm), NW Shelf, 19°56.9'S, 117°53.6'E, 43m, 18/2/1983, T.Ward R.V.*Soela* CSIRO; QM W10531 ♂ (ca 8.0mm), NW Shelf, 19°29.6'S, 118°51.7'E, 40-41m, 25/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10532 2♀ (3.7-5.2mm), NW Shelf, 19°58.3'S, 117°49.4'E, 43m, 25/6/1983, T.Ward R.V.*Soela* CSIRO; QM W10533 ♂ (3.6mm), NW Shelf, 19°56.7'S, 117°53.6'E, 40m, 26/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10534 ♀ (6.1mm), ♀ (4.1mm), NW Shelf, 19°56.7'S, 117°53.6'E, 41m, 26/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10535 ♂ (6.4mm), ♀ (8.0mm), NW Shelf, 19°30.8'S, 118°49.4'E, 38m, 30/8/1983, T.Ward R.V.*Soela* CSIRO; QM W10536 ♀ (5.4mm), NW Shelf, 19°58.9'S, 117°51.7'E, 42m, 27/8/1983, T.Ward R.V.*Soela* CSIRO; QM W10539 2♀ (5.2-6.0mm), NW Shelf, 19°29.4'S, 118°52.4'E, 38m, 25/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10540 ♂ (6.8mm), NW Shelf, 19°29.7'S, 118°52.1'E, 38-39m, 25/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10541 2♂ (3.6-6.1mm), ♀ (6.9mm), NW Shelf, 19°29.6'S, 118°52.2'E, 36m, 25/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10542 ♂ (3.1mm), NW Shelf, 19°29.6'S, 118°52.5'E, 39-40m, 28/6/1983, T.Ward R.V.*Soela* CSIRO; QM W10543 ♂ (3.5mm), ♀ (4.1mm), NW Shelf, 19°29.5'S, 118°52.2'E, 37m, 24/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10545 ovig ♀ (8.9mm), NW Shelf, stn 2, 7/10/1983, I.Poiner CSIRO; QM W10547 ♂ (5.7mm), NW Shelf, 19°45.7'S, 117°52.0'E, 54m, 20/2/1983, T.Ward R.V.*Soela* CSIRO; QM W10548 ♂ (6.1mm), NW Shelf, 19°56.8'S, 117°53.4'E, 42m, 22/4/1983, T.Ward R.V.*Soela* CSIRO; NTM Cr.6581 ♀ (6.0mm), juv., NW Shelf, 19°59.0'S, 117°51.2'E, 40m, 22/4/1983, R.V.*Soela* CSIRO; WAM 1069-86 ♂ (9.5mm), NW Shelf, stn 2, 7/10/1983, I.Poiner CSIRO; NTM Cr.3058

♂ (6.8mm), ovig ♀ (6.5mm), Fog Bay, Northern Territory, 20m, 12/7/1985, I.Archibald; WAM 1066-86 ♀ (8.1mm), Darwin, N Australia, trawled, Sept.1965, E.Barker; NTM Cr.4074 ♂ (11.9mm), Gulf of Carpentaria, north of Groot Eylandt, *Gemini* stn AP, 13°30'S, 136°30'E, 15-16/8/1976, P.Elder N.T.Fish. Dept; QM W10501 ♂ (5.6mm), Gulf of Carpentaria, stn S301, 00.30-01.00 hrs trawl, 11m, 14/11/1977, I.Poiner CSIRO; AM P16994 4♂ (7.9-11.4mm), Gulf of Carpentaria, *Rana* stn 571, 16°30.35'S, 139°45.30'E, trawled, 22m, Jan. 1964, CSIRO Prawn Survey; BM 1882:7 ♂ (9.4mm), Thursday Island, no.145, 2-8m, sand, Aug.1881, Dr R.Coppinger HMS *Alert*; BM 1882:7 ♀ (9.3mm), Thursday Island, no.175, 2-8m, sand, Aug.1881, Dr R.Coppinger HMS *Alert*; BM 1882:7 ♂ (5.0mm), Prince of Wales Channel, no.157, 18m, sand, Sept.1881, Dr R.Coppinger HMS *Alert*; AM P36796 ♂ (8.5mm) and P36797 damaged (juv.), Torres Strait, Arafura Sea, stn 1, 10°38'S, 141°6.5'E, 0645-0710 hrs, water temp. 28°C, 5m otter trawl, wire out 150m, time at depth 10mins, depth 25m, 16/3/1975, E.Ball Alpha Helix Exped; QM W10544 ♂ (9.4mm), Torres Strait, 10°02'S, 142°31'E, Torres Strait Prawn Survey stn 300, 13m, 21/4/1974, Qld.Fisheries; QM W10546 ♂ (8.0mm), Torres Strait, 10°02'S, 142°35'E, Torres Strait Prawn Survey stn 298, 15m, sand and shell, 21/4/1974, Qld. Fisheries; QM W10523 ♂ (8.4mm), Torres Strait, 10°2'15"S, 142°36'50"E, Torres Strait Prawn Survey stn 29, sand, 24/3/1974, Qld.Fisheries; QM W10529 ♂ (7.7mm), Torres Strait, 10°12'30"S, 142°41'30"E, Torres Strait Prawn Survey stn 383, 18m, shelly, 2/5/1974, Qld. Fisheries; QM W10530 ♂ (11.9mm), Torres Strait, Torres Strait Prawn Survey stn six 9 NCD, 18-27m, 28/8/1974, Qld.Fisheries; QM W10550 ♀ (10.0mm), Torres Strait, 9°45'S, 143°27'E, stn 17, trawled, 30m, 17/9/1988, I.Poiner R.V.*Kulasi* CSIRO; BM 1970:121 ♀ (6.7mm), 1/2 mile SE of Lizard Is., off Lookout Point, stn xiv, 35m, 7/3/1929, Great Barrier Reef Exped. 1928-29; BM 1970:122 ♀ (5.9mm), in lee of Turtle Isles, off Lookout Point, 15m, 12/3/1929, Great Barrier Reef Exped. 1928-29; QM W9930 ♀ (10.0mm), 15 miles east of Hinchinbrook Is., 18°17'S, 146°31'E, BSQ stn 131, coral rubble, 31m, 17/10/1979, Qld. Fisheries; QM W10549 ♂ (8.9mm), 2♀ (4.3-4.8mm), Abbot Point north of Bowen, N Qld., James Cook Uni; AM P18067 2♂ (5.4-7.0mm), ♀ (6.7mm), off North Keppel Is., N Qld., 51m, Aug.1970, T.Nielsen. (This lot also contains two undetermined juvenile 3.0mm specimens). AM P20006 ♂ (6.6mm), ♀ (6.3mm), South Keppel Is., N Qld., 9-15m, Sept.1970, N.Coleman; QM G14/289 ♂ (15.0mm), Moreton Bay, SEQ, J.Palmer; QM W2942 2♂ (4.7-5.3mm) and W2946 ♀ (5.2mm), Moreton Bay, 3/4 mile NW of M1 red buoy, stn 271, 27°10'50"S, 153°18'20"E, sand and broken shell, 14m, 29/8/1967, W.Stephenson; QM W7406 ♀ (10.9mm), Cowan Cowan, Moreton Bay, SEQ, J.Palmer; QM W10500 6♂ (7.3-8.9mm), 2♀ (5.9mm), channel near Dring Banks, SW of Tangalooma, Moreton Bay, SEQ, clean sand, 14-15m, 15/11/1981, R.Willan; QM W10527 ♂ (8.2mm), south end of Dring Banks, Moreton Bay, SEQ, stn 156, dredged, sand, 29/4/1964, W.Stephenson; QM W10538 ♀ (7.3mm), 1/4 mile south of Dring Banks, Moreton Bay, SEQ, dredged, 18m, 29/4/1964, W.Stephenson; QM

W11363 (7.8mm), Middle Banks, Moreton Bay, SEQ, sta. 24, 11.5m, clean sand, June 1973, S. Cook and S. Newlands.

#### DESCRIPTION

*Chelae.* Hand of left cheliped with a row of six or seven spines on upper inner border, larger proximally. Outer surface strongly convex and scutellated, each scute with a fringe of plumose setae on the distal edge. Lower scutes have a more convex distal border and are half or less the length of upper scutes. Upper scutes with 1-6 large white tubercles along their length, lower with one or none. Rudimentary tubercles also present particularly on upper scutes. On small specimens the large tubercles are smaller and less numerous and the rudimentary tubercles absent. Inner surface of hand with a few weak scales, some with bristles at their distal edge. Lower border with two rows of tubercles, more obvious in larger specimens, with a few bristles between the tubercles especially distally. When viewed from the inner side the lower border consists of rounded tubercles that do not carry spines. The exterior view shows the lower border as a row of scutes with large tubercles on their lower border. The fingers have much smaller scutes, with tubercles about the same size as those on the hand. Carpus of left cheliped with a row of spines on upper border, increasing in size distally. Smaller spines are present on upper half of outer surface being replaced by spiny scutes on lower half.

Merus of left cheliped triangular in section with small spines on outer distal edge and outer lower distal corner. Inner lower border is a crest divided into seven large rounded teeth, all about equal size.

Right cheliped with tufts of long bristles on the external surface, those on upper half arising from the base of spines. Upper surface of dactylus is spinous. Upper surface of carpus with a bare, oval area surrounded by 7-8 spines. There is no trace of scutes on right cheliped.

*Third left leg.* Dactylus slightly curved and longer than propodus. Inner surface convex with a longitudinal, median groove which has a row of bristles on the distal third. Inner lower border with a row of small sharp spines on proximal half; upper border spinous with bristles. Outer surface of dactylus flattened with a longitudinal median groove either side of which are transverse scutes. Scutes on upper side of the median groove have small tubercles on their distal edge and spines where they form the border of the dactylus. Scutes on lower side have one large tubercle near border of dactylus and a few much smaller ones towards the groove. Distal edge of scutes is fringed with

plumose setae which become longer towards edges of dactylus where they mix with tufts of long bristles.

Propodus almost naked on inner surface, lower border notched due to scutes on outer surface being truncated at lower margin. The end of each scute carries a tuft of bristles and a spine. Outer surface convex with two rows of scutes either side of a bare median area. Scutes on upper row have small tubercles, those on lower row have larger tubercles with the tubercle near the edge of propodus very much larger. Tubercles are not well developed on smaller specimens and almost non-existent on the very small. Both edges of propodus have long bristles and plumose setae.

Carpus with 2-3 strong spines on upper border; outer distal edge serrated. Inner surface flat, outer surface strongly convex. All surfaces smooth with very few tufts of bristles.

Merus has outer surface convex and inner surface flat. There are 2-3 spines half way along lower inner border. All surfaces smooth with very few tufts of bristles.

*Fourth left leg.* Carpus has two large and 2-3 small spines on upper surface.

*Eye-stalks.* Eye-stalks shorter than antennular peduncles, eye occupies more than one-third of eye-stalk. Ophthalmic scales broad, well separated at their bases and have three sharp spines on their anterior margins.

*Colouration.* Colours given are of preserved specimens. Most colours persist for 10-12 years. Body white to greyish cream. Except for the outer surface of dactylus of the third left leg, dactyli of legs are scarlet to brick red with cream blotches at the base of the tufts of bristles. Scutes on lower half of hand including immovable finger and lower part of movable finger are scarlet to brick red. This colouration ends abruptly where the hand is most convex (at about half the height of the hand). Tubercles on the scutes are white. Upper surface of carpus of both chelipeds bluish grey. Scutes on outer surface of dactylus of third left leg also scarlet to brick red and the tubercles white. Only scutes on the lower half of the propodus of the third left leg are pigmented; sometimes only the distal edge is coloured. The colouration being the same as for the dactylus. Eye-stalks purple for their proximal one third then a band of brown which fades distally to base of eyes.

#### REMARKS

Because of the similarity of the species involved and the brief description given by Milne Edwards, examination of the holotype of *D. imbricatus* was

considered necessary. Dr J. Forest (MNHN) however has failed to locate the type and it must therefore be presumed lost. He agreed that the erection of a neotype was necessary.

While both *D. squarrosus* sp. nov. and *D. callichela* sp. nov. also fit Milne Edwards' description of the left cheliped and the third left leg only *D. squarrosus* sp. nov. and the present specimens approximate to his vague description of the colour . . . 'Colour whitish mixed with pale red.' The collecting location of Milne Edwards' specimen, Raffles Bay (Northern Territory, Australia), is well within the geographic range of the present specimens while the only known location for *D. squarrosus* sp. nov. is almost 700km further south and 1000km further west. As previous workers have referred to some of the present specimens as *D. imbricatus*, and because of the above facts a neotype was selected from the present specimens following the rules of the I.C.Z.N. The new type locality (Casuarina Beach, Darwin) is about 210 kilometers south-west of the previous type locality (Raffles Bay).

Miers (1876), while not having any specimens, recorded this species from New Zealand. Presumably he thought Raffles Bay to be in that country. His mistake led subsequent workers to include New Zealand when giving the distribution of *D. imbricatus* even though the mistake was pointed out by both Hutton (1882) and Filhol (1886). Miers also states 'There are two specimens from Shark's Bay, W. Australia, which probably belong to this species, in the collection of the British Museum.' Unfortunately these specimens can no longer be located. However as some of the present specimens come from the same area it is not unreasonable to assume that Miers' specimens were *D. imbricatus*. This assumption is supported by the fact that Miers (1884) recorded three specimens from Torres Strait (BM 1882:7). These have been examined and are *D. imbricatus*. He commented on the variation of the tubercles on the scutes of the left cheliped suggesting that the tubercles develop and increase in size as the animal becomes larger. The present material supports Miers' observations, however there is also considerable variation between larger specimens as shown in Figure 2.

Henderson (1888) records *D. imbricatus* from Flinders Passage, Torres Strait. Although his specimens cannot be located his notes are precise enough to confirm his identification. Ortmann (1894) also records *D. imbricatus* from Torres Strait; however, as his material could not be located, the true identity of his specimens must remain in doubt. McNeill (1968) records two

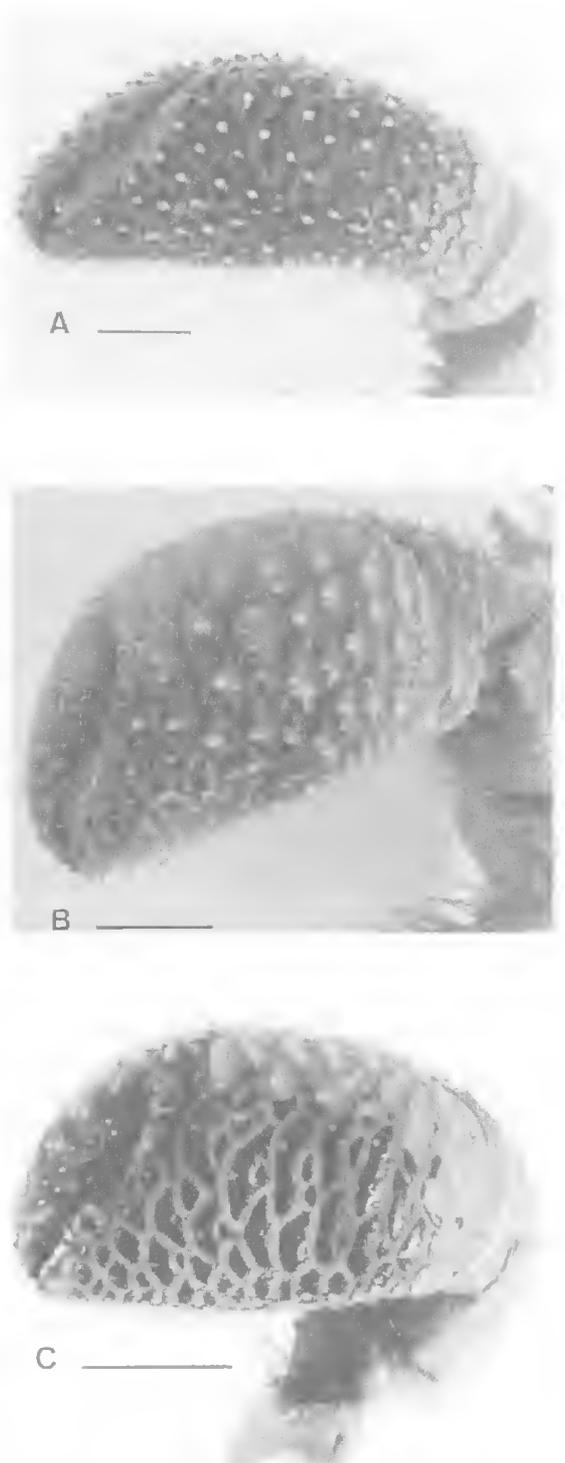


FIG. 2. Outer surface of left cheliped. *Dardanus imbricatus* (H. Milne-Edwards), A. Neotype, ♀ (11.6mm), NTM Cr.3444; B. ♂ (11.9mm), QM W10530; C. oviger ♀ (8.9mm), QM W10545. (Scale = 5.0mm).

specimens from Lizard Island (BM 1970:121, 1970:122) both have been examined and belong to the present species. Haig and Ball (1988) correctly record two specimens from Torres Strait (AM P36796-7). They mention the presence of anemones on the shell of one specimen and give colour notes. Few shells have been kept with the present specimens but most carry at least one anemone. Twelve species of shells are represented suggesting little if any preference for particular shells.

#### DISTRIBUTION

Northern half of Australia from Shark Bay (W. Australia) in the west to Moreton Bay (Queensland) in the east.

Depth Range: 6-54 m.

#### *Dardanus callichela* sp. nov. (Figs 3, 6B, 8A)

*Pagurus imbricatus*: Alcock, 1905, p. 92, pl. 9, fig. 8;  
Fize and Serène, 1955, p. 220, fig. 35 A-C, pl. 6, figs.  
11-14.

?*Dardanus imbricatus*: Khan and Natarajan, 1984, p. 11,  
fig. 8.

#### MATERIAL EXAMINED

HOLOTYPE: QM W10520 ♀ (14.7mm), NW Shelf, 20°25.4'S, 116°02.6'E, stn 48, 38m, 14/10/1983, I. Poiner CSIRO.

PARATYPES: MNHN Pg.2271 ♂ (19.6mm), Cape St Mary, 17°13'11"N, 107°41'08"E, stn 45, trawl 43, grey mud, 73m, 12/9/1963, Fish. Research Stn. Hong Kong; NTM Cr.4187 ♂ (7.5mm), NW Shelf, 20°01.4'S, 116°57.5'E, 52m, 22/2/1983, T.Ward R.V.*Soela* CSIRO; WAM 1068-86 ♀ (9.0mm), NW Shelf, 20°3.7'S, 116°13'E, stn 45, 37m, 14/10/1983, I. Poiner CSIRO; QM W10518 ♂ (8.3mm), NW Shelf, 19°45.8'S, 117°52.1'E, 52m, 2/9/1983, T.Ward R.V.*Soela* CSIRO; QM W10521 ♂ (13.0mm), NW Shelf, 19°35.8'S, 117°45.9'E, 60m, 12/10/1983, I. Poiner CSIRO; QM W10522 ♂ (14.9mm), Chesterfield Reefs, Coral Sea, 19°15.00'S, 158°34.00'E, stn DW 68, 65m, 24/7/1988, P. Davie R.V.*Coriolis*; MNHN Pg.4447 ♀ (12.8mm), Chesterfield Reefs, Coral Sea, 20°28.02'S, 160°56.34'E, stn DW 28, 78m, 22/7/1988, P. Davie R.V.*Coriolis*.

OTHER MATERIAL: MNHN Pg.1266-7 2♂ (15.0-20.0mm), Gulf of Siam, 8/12/1927, A. Krempf; MNHN Pg.2323 ♀ (10.0mm), Cr 4/63, sta 2, T/17. [no other data]; NTM Cr.6582 ♂ (11.5mm), ?18°07.1'S, 118°13.7'E, stn T/28/62, 350m, 2/2/1984, R.V.*Soela* CSIRO; QM W10537 ♂ (8.1mm), NW Shelf, 18°56.9'S, 118°45.2'E, 86-88m, 7/12/1982, T.Ward R.V.*Soela* CSIRO.

#### DESCRIPTION

*Chelae*. Hand of left cheliped with a row of six or seven spines on the upper inner border. Outer

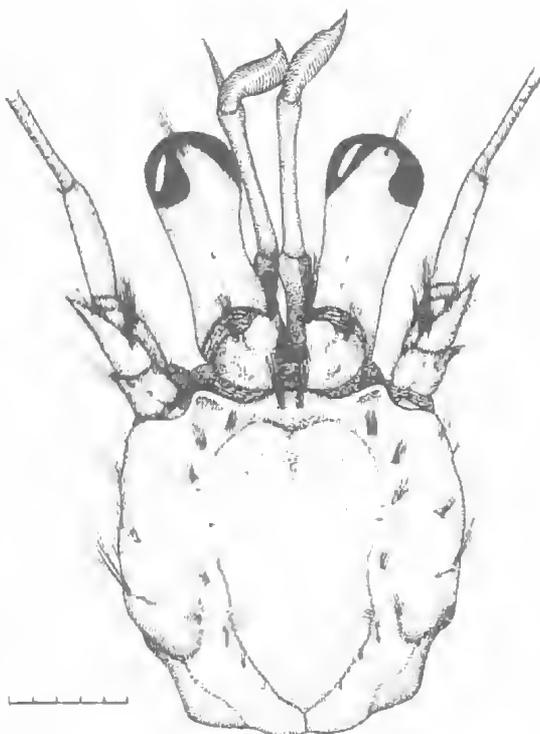


FIG. 3. *Dardanus callichela* sp. nov. Shield and cephalic appendages. Holotype, ♀ (14.7mm), QM W10520. (Scale = 5.0mm).

surface strongly convex and scutellated with a fringe of plumose setae on the distal edge of each scute. Scutes on unworn specimens have from 0-5 small sharp spines on the anterior edge. There is no relationship between scute size and number of spines. Inner surface of hand with a few weak scales some with bristles at their distal edge. Lower border with long plumose setae which form a thick brush. When viewed from the inner side the lower border consists of robust multidentate spines. The exterior view shows fine outwardly directed spines protruding through plumose setae. Spines arise from the distal edge of scutes along the lower border however these scutes are mostly hidden by plumose setae. Fingers also scutellated, with spinous scutes at lower border of immovable finger and upper border of dactylus.

Carpus of left cheliped with a row of spines on upper border, increasing in size distally. Smaller spines are present on upper half of outer surface being replaced by spiny scutes on lower half.

Merus of left cheliped triangular in section with spines on outer distal edge and outer lower distal corner. Lower third of outer surface scutellated. Inner lower border is a crest divided into seven acute teeth of about equal size.

Dactylus and propodus of right cheliped covered with tufts of long bristles. Four rows of spines run along dorsal surface of the dactylus; propodus with spinous upper half. Upper surface of carpus with a bare, flat, oval area surrounded by seven large spines. There are no scutes on the right cheliped, although the bases of the tufts of bristles give a scutellated appearance.

*Third left leg.* Bordered by a dense brush of long bristles and plumose setae, the dactylus longer than propodus. Inner surface of dactylus with a longitudinal, median row of stiff bristles on distal quarter. Small patches of bristles are scattered over the rest of the surface, upper proximal ones having spinous bases. Upper border with a row of long sharp spines just inside the brush of setae. Proximal half of lower border with a row of spines decreasing in size distally. Outer surface of dactylus flattened with a smooth, longitudinal, median area, ill-defined in larger specimens, either side of which are transverse scutes. Distal edge of each scute fringed with plumose setae becoming longer towards edges of the dactylus where there are also long bristles. Scutes have 1-2 spines where they meet the edge of the dactylus.

Propodus with a row of large spines, single and multidentate, along the lower inner edge and except for a few spines on the upper part the rest of the inner surface is almost naked. Outer surface convex with two rows of scutes. Scutes have spines where they form the edge of the propodus.

Carpus scutellated on outer surface. Scutes are spinous with the fringe of plumose setae becoming longer towards edges of carpus. Outer distal edge of carpus with a large scute, the distal edge of which is spinous and fringed with long plumose setae. Upper surface with tufts of long plumose setae and bristles intermixed with spines at the distal edge. Inner surface smooth, slightly convex with three large spines on lower distal border and two large and one small spine on upper distal border.

Outer surface of merus weakly scutellated on lower distal half. Scutes spinous with long plumose setae where they form the distal edge. Lower edge has long bristles with 3-4 strong teeth.

*Fourth left leg.* Carpus with 6-7 long, sharp, curved spines on upper surface.

*Eye-stalks.* Eye-stalks shorter than antennular peduncles, eye occupies more than one third of eye-stalk. Ophthalmic scales broad, well separated at their bases and have three large spines on their anterior margin, just posterior is a row of bristles.

*Colouration.* Colours are for recently preserved specimens (since 1982). Body cream with a scat-

tering of tiny scarlet dots on all calcified areas including telson. Dactylus of walking legs orange to brick red, with cream blotches at base of tufts of bristles. Distal half of fingers on right cheliped similarly coloured. Scutes on fingers and hand of left cheliped pink bordered by scarlet, some with a lilac hue. The colour is most brilliant on lower part of hand and immovable finger. Where the hand is most convex colour fades and scutes above this area have very little colouration. Scutes on outer surface of dactylus and propodus of third left leg are similar to those on lower part of hand. Proximal half of eye-stalks royal purple.

#### REMARKS

Both Alcock (1905) and Fize and Serène (1955) have illustrated and commented on this species believing their specimens to be *D. imbricatus*. This is no doubt due to Milne Edwards' (1848) inadequate description, and the fact that this species has 'imbricate scales' on the left cheliped.

Alcock's (1905) description (including colouration) and figure are precise enough to place his specimen in this species. The only point of disagreement between his description and the present specimens being the outer surface of the carpus of the left cheliped. Alcock's specimen differs in that '... its carpus has the upper (inner) border spinose, and all the outer surface covered with imbricating squamiform tubercles, . . .' although his illustration shows no such sculptures. On the present specimens the ornamentation is only on the lower half and weakly represented. Alcock also points out the difference between this specimen and *Pagurus striatus* (< *Dardanus arrosor*) a species with squamiform markings on both left and right chelae and legs.

Fize and Serène repeat Alcock's description and use it for the basis of their identifications. They give the colouration of their specimens with which the present specimens agree. They also comment on observations made by Miers (1884) and Henderson (1888) regarding tubercles on the left cheliped (see *D. imbricatus*) pointing out that their (Fize and Serène) specimens do not have any such tubercles. They further suggest that the specimens of Miers and Henderson '... possibly belong to a different species (*P. pectinatus*)'. Fize and Serène say they accept Alcock's separation of *P. imbricatus* from *P. arrosor* but express doubt about the significance of the scales on legs 1-3 on the right side in *P. arrosor* and give a lengthy comparison between *P. imbricatus*, *P. arrosor*, *P. pectinatus* and *P. insignis*, the latter 3 species having been discussed in some detail by Schmitt (1926). As *P.*

*pectinatus* and *P. insignis* are Atlantic species Fize and Serène's comparison seems irrelevant. The figure by Fize and Serène leaves no doubt that their specimens belong to the present species.

Ajmal Khan and Natarajan (1984) give little to help with the identity of their specimen. Their brief colour notes together with the locality of their specimen (Bay of Bengal) suggest that their specimen may belong to the present species. Their figure is not detailed enough to be of any assistance.

#### ETYMOLOGY

The specific name refers to the colouring of the left cheliped, and is from the greek *callos* (beautiful) and *chele* (claw).

#### DISTRIBUTION

Sri Lanka, South China Sea, NW Australia and Chesterfield Reefs.

#### DEPTH RANGE

37-88m. The depth of 350m recorded for NTM Cr.6582 is in some doubt as the locality data for this specimen was queried on the specimen label, and it is substantially deeper than all other records.

#### *Dardanus corrugatus* sp. nov.

(Figs 4,6C,8B)

#### MATERIAL EXAMINED

HOLOTYPE: NTM Cr.3665 ♂ (12.8mm), Observation Point, Port Essington, 11°16.8'S, 132°10.5'E, stn CP-59, rocky reef, 15/3/1983.

#### DESCRIPTION

*Chelae*. Hand of left cheliped with a row of seven spines on upper inner border, larger proximally. Outer surface embossed by more or less vertical ridges finely granular on their distal edge. The ridges vary in length and are shorter, wider and more scale-like on the fingers. Plumose setae, approximately as long as the ridges are wide, originate from under the granules forming a fringe and giving a somewhat banded effect. The ridges are truncated on the sinuous lower margin giving a palisade effect. This can only be seen from the inner side as the outer side is hidden by a row of tufts of bristles which run along the distal three-quarters of lower margin. The end of each ridge on distal two-thirds of lower margin bears 2-3 spines. Dactylus of left cheliped with a row of tubercles, becoming spinous distally, along the dorsal edge. Inner surface of hand has some weakly formed tubercles with bristles on their

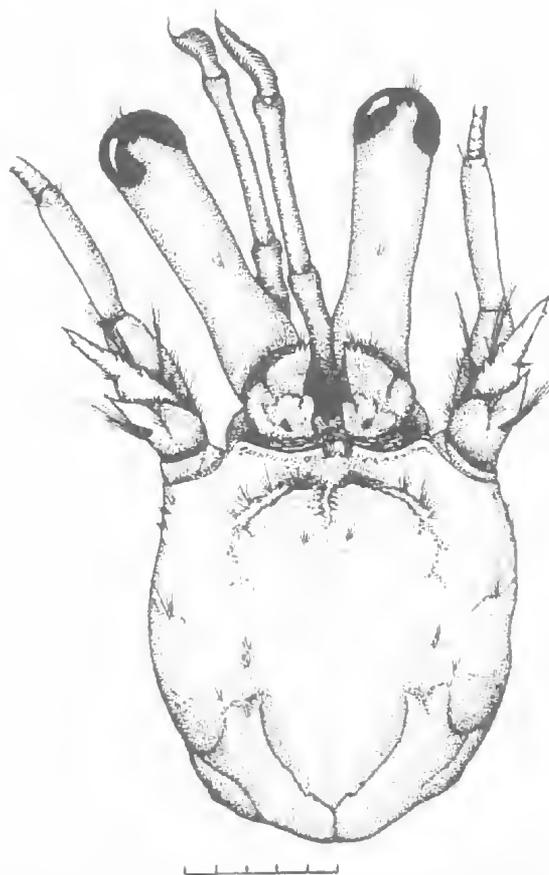


FIG. 4. *D. corrugatus* sp. nov. Shield and cephalic appendages. Holotype, ♂ (12.8mm), NTM Cr.3665. (Scale = 5.0mm).

distal edge, and a few very weakly formed tubercles posterior to the immovable finger.

Upper surface of carpus of hand with a bare, flat, oval area surrounded by 7 large spines. Outer lower surface slightly scutellated, inner surface smooth with strong tooth on lower edge.

Merus of left cheliped triangular in section with three spines on outer upper edge and two at lower distal corner. Inner lower border is a crest divided into seven large rounded teeth, larger proximally.

Right cheliped with tufts of long bristles on dactylus and propodus. Two rows of spines run along the dorsal surface of the dactylus and propodus. Carpus with a flat, bare, oval area surrounded by seven large spines. Propodus also with a bare, flat area on upper proximal surface. There is no trace of scutes on the right cheliped.

*Third left leg*. Dactylus strongly curved and longer than propodus. If a chord is drawn the

greatest distance between it and the dactylus approximates to the height of the dactylus at that point. Inner surface convex with a shallow longitudinal groove which has a row of stiff bristles along the ventral edge. Lower inner border with a row of equally spaced tufts of bristles; upper inner border more or less covered by tufts of bristles. Outer surface of dactylus flattened with a faint, longitudinal, median groove which bears some small, transverse scutes and has tufts of bristles along both edges. Either side of the longitudinal groove are scutes whose distal edge has a fringe of plumose setae and a hint of granulation.

Propodus almost naked on inner surface while outer surface is slightly convex with two rows of scutes similar to those on the dactylus.

Carpus with two strong spines on upper distal border; outer distal edge serrated. Both carpus and merus have their inner surface flat and outer surface convex, all are smooth with very few tufts of bristles.

Merus with three spines half way along the inner lower border.

*Fourth left leg.* Carpus of left leg with one spine on the upper surface.

*Eye-stalks.* Eye-stalks only just shorter than antennular peduncles; eye occupies about one quarter of eye-stalk. Ophthalmic scales broad with sharp spines on their anterior margin.

*Colouration.* Body cream, scutes on left cheliped and outer surface of third left leg maroon. Tips of larger granules on these scutes white. Upper surfaces of carpus of both chelipeds iridescent blue-grey. Patches of blue-grey and maroon together with cream give a mottled effect on the inner surface of propodus, carpus and merus of both chelipeds. Walking legs similarly coloured, and in addition having a maroon band on each propodus and a slightly lighter band on each carpus and merus. Ophthalmic scales and front region of carapace have traces of lavender. Eye-stalks lavender with pale orange on their bases and midway along their length.

#### ETYMOLOGY

The specific name refers to the sculpturing on the left cheliped, and is latin for ridged or wrinkled.

#### DISTRIBUTION

Known only from the type locality.

*Dardanus squarrosus* sp. nov.  
(Figs 5,6D,8C)

*Pagurus imbricatus*: Balss, 1921, p.21.

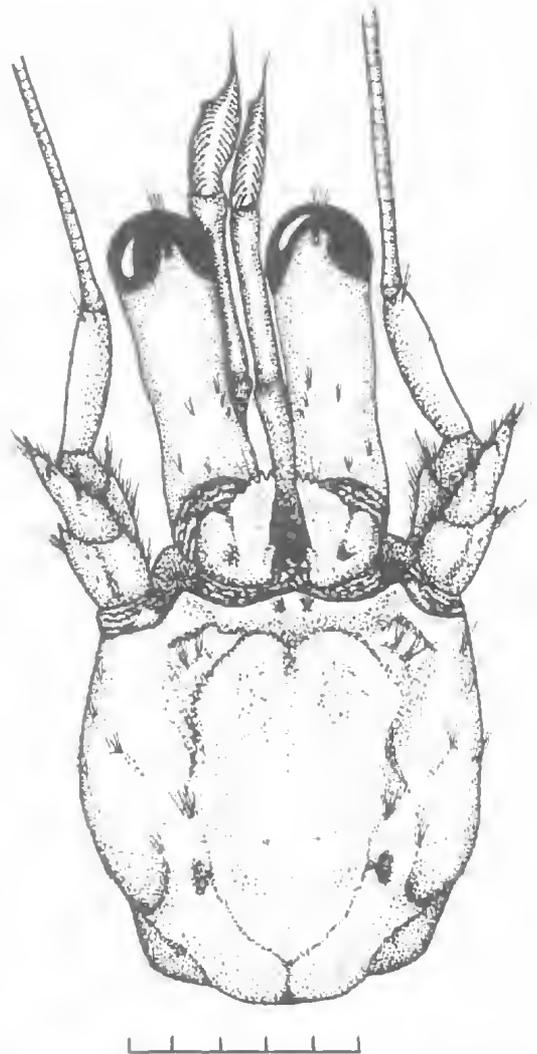


FIG. 5. *D. squarrosus* sp. nov. Shield and cephalic appendages. Holotype, ♂ (9.4mm), NRS 11003. (Scale = 5.0mm).

#### MATERIAL EXAMINED

HOLOTYPE: NRS 11003 ♂ (9.4mm), Cape Jauberi, NW Australia, 45 miles WSW, 18m, 14/7/1911, E.Mjoberg.

PARATYPE: WAM 1067-86 ♂ (10.2mm), no data available. (Presumably W. Aust.).

#### DESCRIPTION

*Chelae.* Hand of left cheliped with a row of seven spines on upper inner border. Entire outer surface covered with scutes of various sizes. Distal edge of most scutes convex to varying degrees and fringed with plumose setae. Scutes have 0-3 rounded tubercles towards their distal edge. Scutes at the lower border are truncated giving a palisade

effect on the inner side; on the distal two-thirds truncated ends of scutes have 2-3 spines. Dactylus of left cheliped with scutes similar to those on the hand and with spinous tubercles on the dorsal edge. Inner surface of hand has weak tubercles with bristles on their distal edge.

Carpus of left cheliped with a bare, flat, oval area surrounded by seven large spines on upper surface. Outer surface with traces of scutes; inner surface smooth with a strong tooth on lower edge.

Merus of left cheliped triangular in section with three spines on outer upper edge and three at lower distal corner. Inner lower border is a crest divided into eight large rounded teeth, the largest proximal.

Right cheliped with tufts of long bristles on dactylus and propodus; dorsal surface of both spinous. Carpus with a flat, bare, oval area, surrounded by seven large spines. Propodus also with a bare, flat area on upper proximal surface. There is no trace of scutes on the right cheliped.

*Third left leg.* Dactylus curved and longer than propodus. Inner surface of dactylus convex with a shallow longitudinal groove along which there are tufts of bristles. Lower border finely serrate on proximal one third. Upper inner border spinous with long bristles. Outer surface flattened; upper half excavated especially proximally. Both upper and lower halves with a row of transverse scutes whose distal edge has a fringe of plumose setae becoming longer towards edges of the dactylus. Distal edge of scutes on lower half weakly tubercular with tubercles becoming much larger towards the lower border where some are spinous. Distal edge of scutes on upper half smooth with large slender spines on upper border.

Propodus almost naked on inner surface; lower border notched, due to truncation of scutes on the outer surface, the end of each scute has a large spine and a tuft of bristles. Outer surface with a very convex, smooth area, with transverse scutes either side. Distal edge of these scutes is fringed with plumose setae, becoming longer towards the edges of propodus, and weakly tubercular, tubercles increasing in size towards both edges of propodus where they become spinous.

Carpus with two large spines on upper distal border; outer distal edge consists of multidentate spines. Lower distal margin with three weak, transverse, spinous ridges. Both carpus and merus with inner surfaces flat and outer surfaces convex, all are smooth with very few bristles. Merus with a medial spine on lower inner border.

*Fourth left leg.* Carpus with one spine on upper surface.



FIG. 6. Outer surface of third left leg. A. *Dardanus imbricatus* (H. Milne-Edwards), neotype, ♀ (11.6mm), NTM Cr.3444; B. *D. callichela* sp. nov., holotype, ♀ (14.7mm), QM W10520; C. *D. corrugatus* sp. nov., holotype, ♂ (12.8mm), NTM Cr.3665; D. *D. squarrosus* sp. nov., holotype, ♂ (9.4mm), NRS 11003; E. *D. undulatus* (Balss), holotype, ♀ (8.3mm), NRS Type No.3115. (Scale = 5.0mm).

*Eye-stalks.* Eye-stalks just shorter than antennular peduncles, eye occupies about one quarter of eye-stalk. Ophthalmic scales broad with three large spines on anterior margin.

*Colouration.* Colours are of the preserved paratype, the holotype while still showing colour patterns has faded to a greater degree. Body cream, scutes on left cheliped and outer surfaces of third left leg brick-red. Tips of larger tubercles on these scutes white. Upper surface of carpus of both chelipeds slightly iridescent. Inner surface of propodus, carpus and merus of both chelipeds with patches of brick-red giving a mottled appearance. Walking legs with a brick-red band on propodus, carpus and merus, dactyli mottled brick-red and cream. Eye-stalks with a feint orange band just over half way along length.

#### ETYMOLOGY

The specific name refers to the sculpturing on the left cheliped, and is latin for rough with scales.

#### DISTRIBUTION

The only known locality is Cape Jaubert (W.Australia).

#### *Dardanus undulatus* (Balss, 1921) (Figs 6E, 7, 8D)

*Pagurus undulatus* Balss, 1921, p. 20, fig. 12.

#### MATERIAL EXAMINED

HOLOTYPE: NRS Type No.3115 ♀(8.3mm), Cape Jaubert, NW Australia, 45 miles WSW, 18-22m, -/7/1911, E.Mjöberg.

#### DESCRIPTION

*Chelae.* Hand of left cheliped with a row of seven spines on upper border, larger proximally. Outer surface strongly convex and embossed with more or less vertical, granulated ridges of varying length. The diameter of the granules approximates to the width of the ridges as does the fringe of plumose setae that originates from the distal edge of each ridge. Ridges on dactylus and immovable finger also granular but much shorter and slightly wider than on hand. A group of six short spines is present just posterior to tip of the dactylus. Lower part of hand posterior to the immovable finger with a depressed area which makes the lower margin cristate. Viewed externally the lower border is fringed with very long plumose setae. Inner view shows a palisade effect formed by ridges on the outer surface being truncated at the lower margin. The end of each ridge has three short, robust spines and a tuft of very long

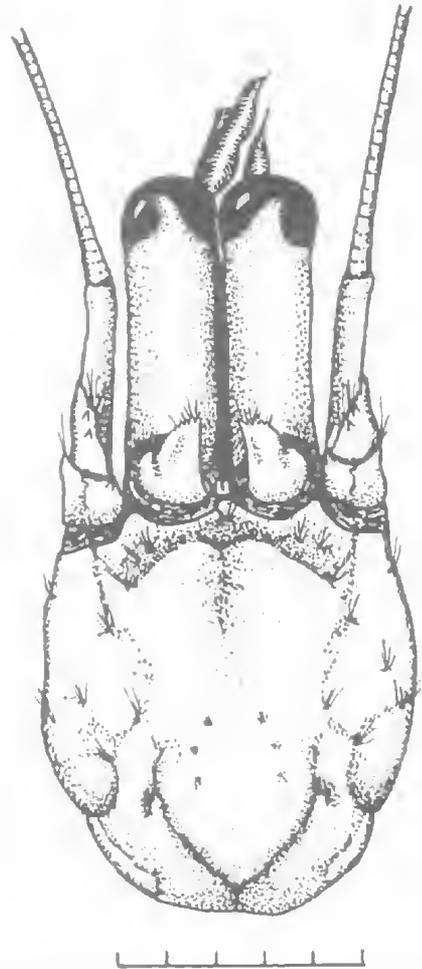


FIG. 7. *D. undulatus* (Balss). Shield and cephalic appendages. Holotype, ♀(8.3mm), NRS Type No.3115. (Scale = 5.0mm).

plumose setae. Inner surface of hand with only a few weak tubercles.

Carpus of left cheliped with a flat, bare, oval area surrounded by eight large spines on upper surface. Outer surface with a few spines that give way to granules on the lower part.

Merus triangular in section with two spines at outer distal edge and two at lower distal corner. Inner lower border is a crest divided into three areas by fissures; the proximal area having two rounded teeth, the middle area a single rounded tooth and the distal area four sharp spines.

Right cheliped with tufts of long bristles; upper surface of dactylus and propodus spinous. Upper surface of carpus with a bare, flat, oval area similar to the carpus of the left cheliped.

*Third left leg.* Dactylus longer than propodus; both thickly fringed with very long plumose setae on outer surface. Inner lower border fringed by bristles; inner upper border has tufts of bristles with spines at their bases. Outer surface flattened with a deep median groove; either side are transverse granular scutes whose distal edge is thickly fringed by long plumose setae becoming much longer towards edges of the dactylus.

Outer surface of propodus with a median ridge; the area above the ridge excavated. Either side of the ridge are transverse granulated scutes fringed with plumose setae. The setae are about as long as the scutes are wide, becoming longer towards the edges of the propodus. The granular scutes on the lower part of propodus extend up on to the median ridge where the granules become larger giving the ridge a granular appearance. Inner surface of propodus smooth, convex and with a row of evenly spaced tufts of bristles along the lower border.

Carpus and merus with smooth, convex inner

and outer surfaces. Carpus with two spines on upper distal edge; outer distal edge granulated and fringed with plumose setae. Merus with two spines on lower inner border.

*Eye-stalks.* Eye-stalks about as long as antennular peduncles, eye occupies less than one quarter of eye-stalk. Anterior border of ophthalmic scales with five spines decreasing in size laterally.

*Colouration.* The specimen has lost all trace of colour. Balss (1921) does not mention the colouration of the specimen.

#### DISTRIBUTION

Known only from the type locality.

#### DISCUSSION

The degree of sculpturing on the external surface of the left cheliped enables the present group of species to be easily separated from all other Indo-West Pacific species in the genus — with the exception of *D. arrosor*. In other species the

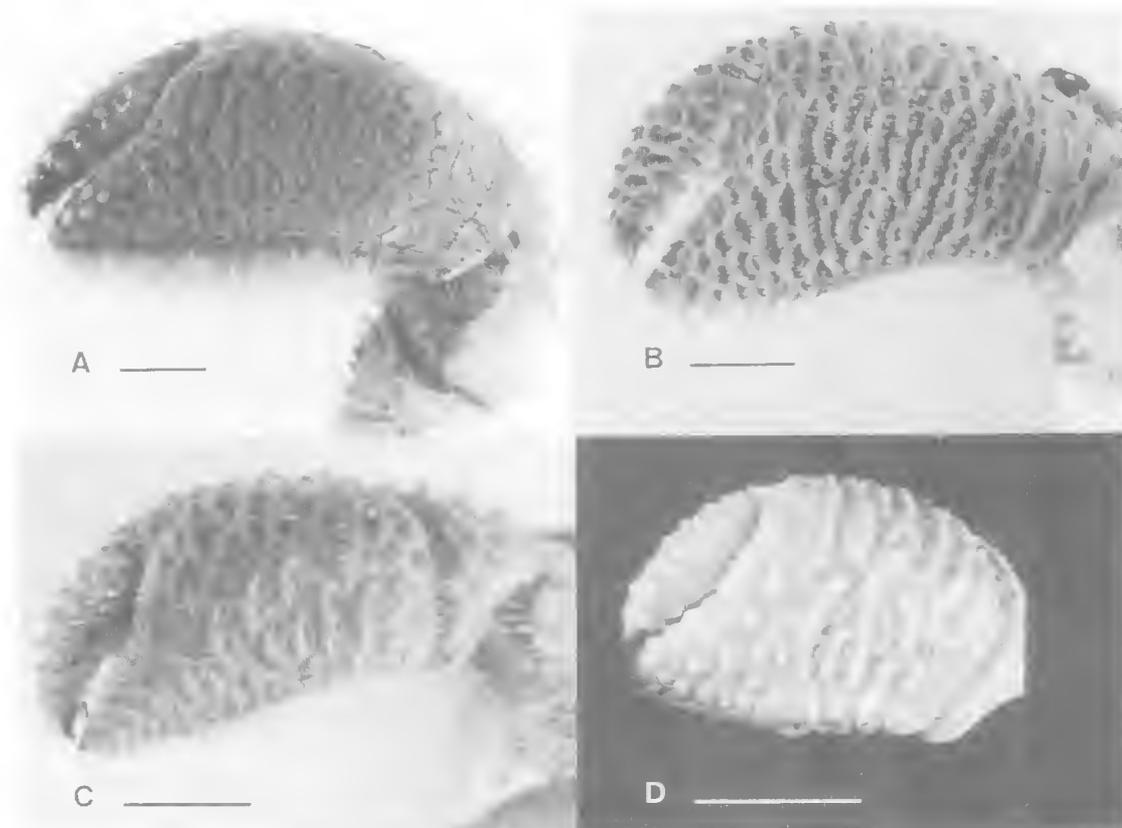


FIG. 8. Outer surface of left cheliped. A. *Dardanus callichela* sp. nov., holotype, ♀ (14.7mm), QM W10520; B. *D. corrugatus* sp. nov., holotype, ♂ (12.8mm), NTM Cr.3665; C. *D. squarrosus* sp. nov., holotype, ♂ (9.4mm), NRS 11003; D. *D. undulatus* (Balss), holotype, ♀ (8.3mm), NRS Type No.3115. (Scale = 5.0mm).

external surface of the left cheliped is either smooth, finely granular or spinous whereas in *D. arrosor* and in the present species it is highly sculptured. As *D. arrosor* has sculpturing on both chelipeds and on all walking legs it is easily separated from all the present species.

Traditionally, species within the genus have been separated into two major groups based on eye-stalk length. Those with short eye-stalks where the cornea occupies a third or more of the eye-stalk and those with long eye-stalks where the cornea occupies a quarter or less of the eye-stalk length. Applying this criterion to the present species-group separates *D. imbricatus* and *D. callichela* sp. nov. with short eye-stalks from *D. corrugatus* sp. nov., *D. squarrosus* sp. nov. and *D. undulatus*.

*Dardanus imbricatus* is separated from *D. callichela* sp. nov. by the presence of tubercles on the scutes of the left cheliped and by the smooth surface of the outer face of the carpus of the third left leg which is scutellated in *D. callichela* sp. nov. For both species ratios were calculated between length/height of the propodus of the left cheliped; eye-stalk length/cornea diameter and between the dactylus/propodus and propodus/carpus of the third left leg. Ratios for both *D. imbricatus* and *D. callichela* sp. nov. showed considerable variations which could not be related to either size or sex. As some values for both species overlapped these ratios cannot be considered as taxonomically important. In the second group *D. squarrosus* is separated by the presence of scutes on the outer surface of the left cheliped. *Dardanus corrugatus* is separated from *D. undulatus* by the former having the outer surface of the propodus of the third left leg slightly convex where as in *D. undulatus* the propodus has a median ridge with the area above the ridge excavated.

#### ACKNOWLEDGEMENTS

I wish to thank the following curators and their institutions for the loan of their specimens: Dr J. Lowry — AM; Dr R.W. Ingle — BM; Dr J. Forest — MNHN; Dr Å. Andersson — NRS; Dr A.J. Bruce — NTM; Dr G. Morgan — WAM. Thanks also to Peter Davie for encouragement and advice through the preparation of the manuscript and for reading the final draft. John Short took the photographs which were printed by Gary Cranich. The line drawings were done by Lynn Prior.

#### LITERATURE CITED

- AJMAL KHAN, S.A. AND NATARAJAN R. 1984. Hermit crabs of Porto Novo Coast. *Rec. zool. surv. India. Misc. Publ. Occ. Pap.* 67: 1-25.
- ALCOCK, A. 1905. 'Catalogue of the Indian Decapod Crustacea in the collection of the Indian Museum. Part 2. Anomura. Fasc. 1. Pagurides'. (Indian Museum, Calcutta). xi + 197pp, 16pls.
- BALSS, H. 1921. Results of Dr. E. Mjöberg's Swedish Scientific Expeditions to Australia 1910-13. XXIX. Stomatopoda, Macrura, Paguridea and Galatheidea. *K. svenska Vetensk.-Akad. Handl.* 61(10): 1-24.
- FILHOL, H. 1886. Crustacés de la Nouvelle Zélande. *Passage de Venus: Mission de l'Ile Campbell, Zool.* III(2): 349-510.
- FIZE, A. AND SERÈNE, R. 1955. Les Pagures du Vietnam. *Notes Inst. océanogr. Nhatrang* 45: 1-IX, 1-228, pls 1-6.
- HAIG, J. AND BALL, E. E. 1988. Hermit crabs from north Australian and eastern Indonesian waters (Crustacea Decapoda: Anomura: Paguroidea) collected during the 1975 'Alpha Helix' Expedition. *Rec. Aust. Mus.* 40(3): 151-96.
- HENDERSON, J. R. 1888. Report on the Anomura collected by H.M.S. "Challenger" during the years 1873-76. *Sci. Rep. Challenger Exped., (Zool.)*, 27: i-ix, 1-122, pls 1-21.
- HUTTON, F. W. 1882. The stalk-eyed crustacea of New Zealand. *N.Z. J. Sci.* Dunedin. 1: 263-64.
- MCNEILL, F. A. 1968. Crustacea, Decapoda and Stomatopoda. *Scient. Rep. Gt Barrier Reef Exped.* 7(1): 1-98, pls 1-2.
- MIERS, E. J. 1876. 'Catalogue of the stalk- and sessile-eyed Crustacea of New Zealand'. (Colonial Museum and Geological Survey Department, London). Pp. i-xii, 1-136, 3 pls.
1884. Crustacea. In 'Report on the zoological collections made in the Indo-Pacific Ocean during the voyage of H.M.S. "Alert" 1881-82'. (British Museum, London). Pp. 178-322, pls 18-34; 513-75, pls 46-52.
- MILNE EDWARDS, H. 1848. Note sur quelques nouvelles espèces du genre Pagure. *Annls Sci. nat. Zool. sér.* 3, 10: 59-64.
- ORTMANN, A. 1894. Crustaceen. In Semon, R., 'Zoologische Forschungsreisen in Australien und dem Malayischen Archipel'. *Denkschr. med.-naturw. Ges. Jena* 8: 1-80, pls 1-3.
- RATHBUN, M. J. 1910. The stalk-eyed Crustacea of Peru and the adjacent coast. *Proc. U.S. natn. Mus.* 38: 531-620, pls 36-56.
- SCHMITT, W. L. 1926. The macruran, anomuran and stomatopod crustaceans collected by the American Museum Congo Expedition, 1909-1915. *Bull. Amer. Mus. Nat. Hist.* 53: 1-63, pls 1-9.